METAL CASTING

Project Fact Sheet

Increased Productivity and Reduced Energy Consumption in Metal Casting Using Titanium Matrix Composite Tooling

New generation of tooling materials result in dramatic improvement in performance

Benefits

- Offers savings of 0.09 trillion Btu by 2010
- Extends sleeve life by 4 to 10 times over H-13 steel
- Reduces downtime as a result of fewer shot sleeve changeovers
- Energy savings of at least 6% achieved by reducing energy losses in holding furnaces and in die preheating during changeovers
- Less lubrication or perhaps no lubrication needed which reduces both cost and emissions

Applications

Can be used in any metal casting operation using H-13 shot sleeves, including squeeze casting, conventional die casting, and semi-solid processing. May be most applicable to producers of die castings for the automotive and aerospace/defense markets where specifications are stringent.

Project Partners

NICE³ Program
Washington, DC

Dynamet Technology, Inc.
Burlington, MA

Case Western Reserve University
Cleveland, OH

Callen Manufacturing Corporation
Northlake, IL

INVENSYS Precision Die Casting Inc
Russellville, KY

SCI Systems Inc
Turtle Lake, WI

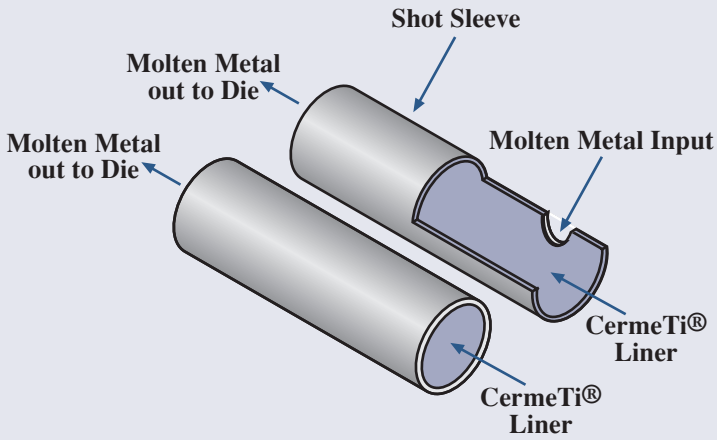
SPX Corp., Contech Div.
Dowagiac, MI

St Clair Die Casting LLC
St Clair, MO

In aluminum die-casting molten aluminum is forced under high pressure into die cavity. First a "shot" of molten aluminum is ladled into a shot sleeve. A plunger then forces the shot of molten aluminum through the shot sleeve into the die cavity. Shot sleeves are subject to severe conditions. Impingement of the shot can cause erosion at the surface across from the pour hole. The shot sleeve is subject to cyclical heating as the shot is delivered then expelled.

The current material of choice for fabrication of shot sleeves and other aluminum die-casting components is H-13 tool steel. The useful life of H-13 is limited because molten aluminum adheres to the surface of the steel eventually causing the failure of the sleeve. This adhesion of aluminum is termed "aluminum soldering". Also H-13 has poor resistance to heat checking, thermal fatigue, erosion, and distortion. Despite H-13's poor performance it continues to be used since it still outperforms other steels. The poor performance of H-13 results in frequent shot sleeve replacements. Shot sleeve replacement results in wasted energy because metal must be kept molten during the tooling changeover, dies must be reheated before casting can resume and the first few castings produced after the changeover are typically rejects. As a result the energy lost accounts for a significant portion of the energy used in aluminum die-casting. CermeTi® is a titanium-alloy metal matrix composite material developed by Dynamet Technology, Inc. CermeTi is used as a liner inserted into an H-13 shot sleeve. This new

Shot Sleeves with CermeTi Liner Material



A new shot sleeve liner material being demonstrated by Dynamet Technology saves energy and waste in the die casting process.

technology has significant advantages over the conventional technology, especially in its resistance to aluminum soldering and erosion. In addition the reduced thermal conductivity of the CermeTi liner reduces heat loss during the injection phase of the casting process. Slower cooling permits the use of lower pouring temperatures (less preheat energy) or slower plunger-tip speeds (less turbulence or surface impingement problems within the die). The result is a dramatic improvement in useful life for the shot sleeve, reducing downtime, improving product quality and saving energy. CermeTi also offers environmental advantages over conventional H-13 tool steel. During the aluminum die-casting process the plunger tip must be lubricated. The lubricant flashes off resulting in gaseous emissions. CermeTi may require less lubrication. Less lubrication means a reduction environmental waste.

Project Description

Goal: To show by production-scale commercial demonstrations that titanium matrix composite tooling materials can be used in the die-casting industry as a liner for shot sleeves and related components (e.g. core pins). During the demonstrations, energy, environmental and economic data will be accumulated to substantiate or to modify the expectations for this technology. The newly developed metal matrix composite is expected to dramatically increase the service life of shot sleeves thus reducing energy consumption during the die-casting process. Dynamet Technology is developing this new technology with the help of a grant funded by the NICE^3 Program in the Department of Energy.

Progress and Milestones

The following are the main tasks to be performed:

- Manufacture of CermeTi material and a demonstration liner for tests at Case Western Reserve University.
- Install and test CermeTi lined shot sleeves in an industrial scale casting machine at Case Western Reserve University.
- Manufacture CermeTi material and machine and install liners in shot sleeves for industrial production trials.
- Install and test the CermeTi lined shot sleeves at industrial demonstration sites.
- Manufacture and test related metal casting tooling components made from CermeTi.

Economics and Commercial Potential

The aluminum die-casting market has demonstrated significant growth over the last decade. Growth is predicted to continue due largely to increased usage in the automotive industry. It is estimated that in 2000 the die-casting industry spent $80 million on dies, molds, jigs and fixtures. Of the $80 million roughly $40 million was spent to purchase about 45,000 shot sleeves. Almost 82% of all die-castings are aluminum therefore roughly 36,000 shot sleeves worth $32.4 million are used in contact with molten aluminum. These shot sleeves are primary candidates for the CermeTi replacement. While the CermeTi lined shot sleeve will cost considerably more initially, its lifetime cost is much less then a conventional H-13 shot sleeve. These benefits are particularly attractive to the producer of die-castings for the automotive and aerospace/defense markets.

Commercial introduction of the technology is expected by 2004. Annual energy savings by 2010 would be 0.09 trillion Btu. By 2020 the savings would grow to 0.83 trillion Btu.

NICE^3 – National Industrial Competitiveness through Energy, Environment, and Economics:
An innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry.
This grant program provides funding to state and industry partnerships for projects that demonstrate advances in energy efficiency and clean production technologies. Awardees receive a one-time grant of up to $525,000. Grants fund up to 50% of total project cost for up to 3 years.

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